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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/757,534

01/15/2004

Hideaki Masuda

05225.0257

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7590

02/08/2005

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EXAMINER

DANG, TRUNG Q

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 02/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/757,534

Applicant(s)

MASUDA ET AL.

Examiner

Trung Dang

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 1-6 is/are allowed.
- 6) ☒ Claim(s) 7-10 and 14-20 is/are rejected.
- 7) ☒ Claim(s) 11-13 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 15 January 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>1/15/04</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

2. Claims 7, 8, 16, 18, and 19 are rejected under 35 U.S.C. 102(e) as being anticipated by Fukuyama (US 6,737,744).

With reference to Figs. 1J, 1K, and 2, Fukuyama teaches a

semiconductor device comprising:

a lower layer interconnection 23 formed on a semiconductor substrate with an insulating film 20 interposed therebetween;

a protective film 30 formed on a surface of the insulating film, including on the lower layer interconnection;

a multilayer-structured film formed by stacking at least a first porous film 31, a first non-porous film 32 (33), and a second porous film 34 on a surface of the protective film in this order (Fig. 1J); and

an upper layer interconnection of dual damascene structure formed in the protective film and the multilayer structured film, the upper-layer

interconnection including a via plug part 42 connected to the lower-layer interconnection and an interconnect part 43 connected to the via plug part with a boundary of the first non-porous film 32 (33) (Fig. 2 and related text),

wherein the first non-porous film is a multilayer film including at least two layers, the first non-porous film 32 (33) including any one of the layers is made of a material which has a high etch selectivity ratio relative to the protective film 30, a layer 32 located close to the first porous film 31 is made of a material which has a high etching selectivity ratio relative to a layer 33 located close to the second porous film 34, and the layer 33

located close to the second porous film 34 is made a material which has a high etching selectivity ratio relative to the second porous film 34.

Note that Fig. 1J depicts etching of the second porous film 34 using the non-porous film 33 as an etch stopper, hence the claimed limitation “the layer located close to the second porous film is made a material which has a high etching selectivity ratio relative to the second porous film” is met.

Fig. 1K depicts etching of the non-porous film 33 and the protective film 30 using the non-porous film 32 as an etch stopper, hence the claimed limitation “the first non-porous film including any one of the layers is made of a material which has a high etch selectivity ratio relative to the protective film, a layer located close to the first porous film is made of a material which has a high etching selectivity ratio relative to a layer located close to the second porous film” is met.

As for claim 16, see col. 5, lines 32-35 in conjunction with col. 4, lines 47-54.

As for claim 18, see col. 5, lines 21-24 for the thickness of the first non-porous film 32 and the thickness of the protective film 30.

As for claim 19, see the second non-porous film 35 (36) in Fig. 1G.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 9, 10, 14, and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fukuyama as above in view of Hedrick et al. (US 6,783,862).

Fukuyama teaches a semiconductor structure as described above.

Fukuyama differs from the claims in not disclosing that the materials the first non-porous film 32 and the first porous film 31 (or the second porous film 34) are of polyarylene ether.

Hedrick teaches a dual damascene structure in which porous films 5 and 13 are made of SiLK and at least one non-porous film 7, 11 also made of SiLK are disposed between the porous films 5 and 13 (Figs. 2C, 3 and col. 4, lines 24-60). Note that polyarylene ether material is known in the art as SiLK (reference to Fitzsimmons et al. is cited to show this fact, but not used in the rejection).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Fukuyama's teaching by employing SiLK (polyarylene ether) as material for layers 31, 32, and 34 as suggested by Hedrick because the use of such material improves toughness, adhesion and reliability of the interconnect structure.

5. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fukuyama as above in view of Higashi et al. (US 6,515,365).

Fukuyama teaches a semiconductor structure as described above.

Fukuyama differs from the claim in that while Fukuyama discloses the diffusion barrier layer 30 is of SiC, the claim calls for the use of any one of SiCH, SiCN, SiCO, and SiN film as a protecting layer (corresponding to the barrier layer 30 of the reference).

Higashi teaches any material including SiN, SiC, SiCN, SiOC can be used for the diffusion barrier film (col. 4, lines 48-56).

The subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to employ materials taught by Higashi for the diffusion barrier film 30 because the

substitution of art-recognized functional equivalent to achieve the same purpose would have been within the level of one skilled in the art.

6. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fukuyama as above in view of Fitzsimmons et al. (US 2004/0094839).

Fukuyama teaches a semiconductor structure as described above.

Fukuyama differs from the claim in that while Fukuyama discloses the hard mask film 36 (corresponding to the claimed second non-porous film) is of SiN, the claim calls for the use of any one of organic siloxane or inorganic siloxane for the film.

Fitzsimmons teaches the use of SiCOH, i.e. siloxane (para.[0031]), for a hard mask layer (para.[0032]).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Fukuyama's teaching by employing siloxane which includes both organic and inorganic siloxane for the hard mask film as suggested by Fitzsimmons because the use of such material for a hard mask film is known, and the application of a known material for performing the same task would have been within the level of one skilled in the art.

Allowable Subject Matter

7. Claims 11-13 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

8. Claims 1-6 are allowed.

9. The following is an examiner's statement of reasons for allowance:

Closet prior art of record is the reference to Fukuyama. However, Fukuyama discloses the etching of via hole 42 and interconnect trench 43 using hard mask 36 as an etch mask but not a resist mask as claimed in independent claims 1 and 4. Consequently, Fukuyama fails to teach or suggest the claimed limitation "a second layer, which is located closer to the second porous film than the first layer made of a material that has a high etching selectivity ratio relative to the resist mask" as claimed in claim 1. Furthermore, as shown in Fig. 1K, the second non-porous film 33 and the protective layer 30 are etched at the same time, hence the reference fails to teaches or suggest the claimed limitation "a second layer,

which is located closer to the second porous film than the first layer is, is made of a material that has a high etching selectivity ratio relative to the protective film..." as recited in independent claim 4. Claims 11-13 are indicated allowable subject matter for the same reason.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Trung Dang whose telephone number is 571-272-1857. The examiner can normally be reached on Mon-Friday 9:30am-6:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Trung Dang
Primary Examiner
Art Unit 2823

02/05/05

A handwritten signature in black ink, appearing to read 'Trung Dang', with a stylized, flowing script.